THE OPEN UNIVERSITY OF SRI LANKA
Faculty of Engineering Technology
Final Examination (2016/2017)
Bachelor of Technology Honours in Engineering

ECX4233: Communication

Closed Book Test

Date: 24th November 2017 (Friday) **Time: 9:30 am – 12:30 pm.**

INSTRUCTIONS TO CANDIDATES

1. This question paper contains **eight** questions in 7 pages.
2. Answer any **Five** questions.
3. All the notations have their usual meaning.
4. Write your answer in short and point form.

Question 1

1. Give two reasons why network operators are interested in global telecommunication standards. **(2Marks)**

2. The classical method of routing in the PSTN networks worldwide was hierarchical routing. Telephone switching offices or exchangers are classified according to their level of hierarchical routing.

   Name five levels of exchanges available in PSTN hierarchical networks and state a unique function of each exchange type. **(5Marks)**

3. Consider a 11-digit international number with 2-digit country code, 2-digit area code and a 7-digit subscriber number. Prefixes "0" and "00" are used for identifying national and international numbers respectively.
   Government special services like ambulance and fire are given short subscriber numbers in the range 100-199. For other special purposes, number range 900-999 is reserved.

   (i) Find the total number of digits with all the prefixes.
   (ii) Calculate the available number space for subscribers
   (iii)The fraction of space lost due to short codes and reservations.

   (9Marks)

4. Draw a functional block diagram of a standard telephone set and explain what is the need of a hybrid in telephone networks? How does it work? **(4Marks)**

Question 2

1. State one advantage and one disadvantage each of 'Time switching' and 'Space Switching'. technique. What advantages are gained by combining these two techniques?

(4Marks)

2. What are single stage and multistage networks? Compare the strengths and weaknesses of each. **(4Marks)**

3. Consider 50-input, 50-output switching system. Find the number of cross points if following type of switching system is used. Assume a full available system.
   (i) Single stage rectangle space switch
   (ii) A 3-stage switch which has 10 number of input stage switching arrays and 10 number of output stage switching arrays and 5 number of center stage switching arrays
   (iii) A 3 stage strictly non-blocking switch which has 10 number of input stage switching arrays and 10 number of output stage switching arrays
   (iv) Hence, give your comments on the best switching arrangement from above (i),(ii) and(iii)

(12 Marks)

Question 3

1. Briefly describe the Pulse Amplitude modulation. Explain how PAM signal is converted to a PCM signal. **(4 Marks)**

2. In a voice communication application, voice signals digitalized by PCM and stored in a RAM buffer and then digital data is processed by the circuitry. Assume bandwidth of the voice signal is 15kHz.
   (i) What is the Nyquist rate for the signal?
   (ii) If the Nyquist samples are quantized to 65,536 levels and then binary coded, determine the number of binary digits required to encode a sample
   (iii) Determine the number of binary digits per second required to encode the audio signal.
   (iv) For practical reasons, signal is required to sampled at a rate above the Nyquist rate. If sampling rate is increased to 44,100 samples per second, and quantization levels is not changed, determine the number of bits per second required to encode the signal.
   (v) Calculate the minimum bandwidth required to transmit the encoded signal in (iv)

(12 Marks)

3. Briefly explain the terms Plesiochronous Digital Hierarchy (PDH) and Synchronous Digital Hierarchy (SDH) and identify the basic differences between these 2 techniques.

(4 Marks)

Question 4

1. What measures the Grade of Service in telecommunication networks? State all the assumption made when deriving Erlangs B formula. **(4Marks)**

2. Starting from Erlang's first formula derive the recurrence relation

$$E_{1,N}(A) = \frac{AE_{1,N-1}(A)}{N + AE_{1,N-1}(A)}$$

(6Marks)

3. A group of 10 trunks provides a grade of service of 0.01 when offered 12 E of traffic.
   (i) How much is the grade of service improved if two extra trunks are added to the group?
   (ii) How much is the grade of service deteriorates if two trunks are out of service?

(6Marks)

4. A group of 20 servers carry a traffic of 10 erlangs. If the average duration of a call is three minutes, calculate the number of calls put through by single sever and the group as a whole in a one-hour period. **(4Marks)**

Question 5

1. What do you understand by "Numerical Aperture" in fiber optic cables?
   Determine the numerical aperture of a single mode fiber where, $n_1 = 1.467$ and $n_2 = 1.465$

(4Marks)

2. A fiber optic system has the following parameters. Input power is 4mW, Loss characteristic is 2dB/km and distance between input node and output node is 3km.
   Find the output power (in milliwatts) of the system. **(6 Marks)**

3. An angle-modulated signal with carrier frequency $\omega_c = 2\pi \times 10^6\ rad/s$, is described by the following equation.

$$\emptyset_{EM}(t) = 15\cos\ (\omega_c t + 5\sin 1000t + 10\sin 2500\pi t)$$

   (i) Determine the power of the modulating signal.
   (ii) What is the frequency deviation (Δf).
   (iii) What is the modulation index (β).
   (iv) Determine $\Delta\emptyset$, the phase deviation.
   (v) Estimate the bandwidth of $\emptyset_{EM}(t)$.

(10 Marks)

Question 6

1. Briefly describe how standing waves arise in transmission lines. **(3 Marks)**

2. Define the Standing Wave Ratio (SWR) and provide the formula for computing it if you know the magnitude of the reflection coefficient.
   What are the bounds (limits) for SWR?

(6Marks)

3. A lossless transmission line of electrical length of 0.3λ and characteristic impedance of 50Ω is terminated with a load impedance $Z_L = (50 + 100)\ \Omega$. Use the same Smith chart to find the following (Clearly show your work on the Smith chart, attached on page 7).

(i) The reflection coefficient of the load.
(ii) The standing wave ratio of the line.
(iii) The reflection coefficient at the input.
(iv) The input impedance.

(8 Marks)

Question 7

1. Briefly describe the following term and mention how they are useful in cellular communication.
   (i) Frequency Reuse
   (ii) Call hand off
   (iii) Sectorization
   (iv) Cell splitting

   (4 Marks)

2. A cellular network consists of 32 cells with each hexagonal cell area of 1.8 km^2. 50.5MHz bandwidth is allocated to the cellular network. From the allocated bandwidth 2.5MHz is reserved for control purposes. The system provides full duplex communication using 25 kHz simplex channels.
   (i) What is the total area covered by the cellular network?
   (ii) Find the total channel capacity if reuse factor is 4, 5 and 7.
   (iii) Comment on the effect of the reuse factor in channel capacity.
   (iv) Calculate number of voice and control channels per cell by considering the reuse factor as 7.

   (12 Marks)

3. When a mobile phone user is moving from one cell to another cell (call is going on), the call is suddenly terminated, even though all the functionalities of the transmitters and receivers are working properly. Assume mobile phone working properly. Explain possible reasons?

   (4 Marks)

Question 8

1. Define the following terms.
   (i) Isotropic antenna
   (ii) Radiation resistance of an antenna
   (iii) Gain of an antenna
   (iv) Polarization

   (4 Marks)

2. The equivalent series circuit of a long wave transmitting antenna is made up of the following parameters

   Inductance = 100 μH Capacitance = 850 pF
   Loss resistance = 1.5 Ω Radiation resistance = 0.3 Ω

   The current through the antenna is 50 A and the operating frequency is 100 kHz. Calculate,

   (i) The radiated power
   (ii) The total input power
   (iii) The efficiency
   (iv) The voltage at the aerial terminals

   (8 Marks)

3. Write shorts notes to following topics
   (i) MPLS cloud
   (ii) Call Handoff and Roaming
   (iii) The advantages of CCS over CAS
   (iv) Optical transport network (OTN)

(8 Marks)

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Supplementary materials

Erlang's B Formula

$$P(N,A) = B = \frac{\frac{A^N}{N!}}{1 + \frac{A}{1!} + \frac{A^2}{2!} + \frac{A^3}{3!} + ... + \frac{A^N}{N!}} = \frac{\frac{A^N}{N!}}{\sum_{X=0}^{X=N} \frac{A^X}{X!}}$$

Where:

A = Average offered traffic
N = No of outlets (circuits)
r = No of simultaneously occupied outlets or circuits

Traffic capacity table for full-availability groups is given in the next page

Number of trunks	1 lost call in 50 (0.02)	100 (0.01)	200 (0.005)	1000 (0.001)	Number of trunks	1 lost call in 50 (0.02)	100 (0.01)	200 (0.005)	1000 (0.001
	E	E	E	E		E	E	E	E
1	0.020	0.010	0.005	0.001	51	41.2	38.8	36.8	33.4
2	0.22	0.15	0.105	0.046	52	42.1	39.7	37.6	34.2
3	0.60	0.45	0.35	0.19	53	43.1	40.6	38.5	35.0
4	1.1	0.9	0.7	0.44	54	44.0	41.5	39.4	35.8
5	1.7	1.4	1.1	0.8	55	45.0	42.4	40.3	36.7
6	2.3	1.9	1.6	1.1	56	45.9	43.3	41.2	37.6
7	2.9	2.5	2.2	1.6	57	46.8	44.2	42.1	38.3
8	3.6	3.2	2.7	2.1	58	47.8	45.1	43.0	39.1
9	4.3	3.8	3.3	2.6	59	48.7	46.0	43.9	40.0
10	5.1	4.5	4.0	3.1	60	49.7	46.9	44.7	40.8
11	5.8	5.2	4.6	3.6	61	50.6	47.8	45.6	41.6
12	6.6	5.9	5.3	4.2	62	51.6	48.8	46.5	42.5
13	7.4	6.6	6.0	4.8	63	52.6	49.7	47.4	43.4
14	8.2	7.4	6.6	5.4	64	53.4	50.6	48.3	44.1
15	9.0	8.1	7.4	6.1	65	54.4	51.5	49.2	45.0
16	9.8	8.9	8.1	6.7	66	55.3	52.4	50.1	45.8
17	10.7	9.6	8.8	7.4	67	56.3	53.3	51.0	46.6
18	11.5	10.4	9.6	8.0	68	57.2	54.2	51.9	47.5
19	12.3	11.2	10.3	8.7	69	58.2	55.1	52.8	48.3
20	13.2	12.0	11.1	9.4	70	59.1	56.0	53.7	49.2
21	14.0	12.8	11.9	10.1	71	60.1	57.0	54.6	50.1
22	14.9	13.7	12.6	10.8	72	61.0	58.0	55.5	50.9
23	15.7	14.5	13.4	11.5	73	62.0	58.9	56.4	51.8
24	16.6	15.3	14.2	12.2	74	62.9	59.6	57.3	52.6
25	17.5	16.1	15.0	13.0	75	63.9	60.7	58.2	53.5
26	18.4	16.9	15.8	13.7	76	64.8	61.7	59.1	54.3
27	19.3	17.7	16.6	14.4	77	65.8	62.6	60.0	55.2
28	20.2	18.6	17.4	15.2	78	66.7	63.6	60.9	56.1
29	21.1	19.5	18.2	15.9	79	67.7	64.5	61.8	56.9
30	22.0	20.4	19.0	16.7	80	68.6	65.4	62.7	58.7
31	22.9	21.2	19.8	17.4	81	69.6	66.3	63.6	58.7
32	23.8	22.1	20.6	18.2	82	70.5	67.2	64.5	59.5
33	24.7	23.0	21.4	18.9	83	71.5	68.1	65.4	60.4
34	25.6	23.8	22.3	19.7	84	72.4	69.1	66.3	61.3
35	26.5	24.6	23.1	20.5	85	73.4	70.1	67.2	62.1
36	27.4	25.5	23.9	21.3	86	74.4	71.0	68.1	63.0
37	28.3	26.4	24.8	22.1	87	75.4	71.9	69.0	63.9
38	29.3	27.3	25.6	22.9	88	76.3	72.8	69.9	64.8
39	30.1	28.2	26.5	23.7	89	77.2	73.7	70.8	65.6
40	31.0	29.0	27.3	24.5	90	78.2	74.7	71.8	66.6
41	32.0	29.9	28.2	25.3	91	79.2	75.6	72.7	67.4
42	32.9	30.8	29.0	26.1	92	80.1	76.6	73.6	68.3
43	33.8	31.7	29.9	26.9	93	81.0	77.5	74.3	69.1
44	34.7	32.6	30.8	27.7	94	81.9	78.4	75.4	70.0
45	35.6	33.4	31.6	28.5	95	82.9	79.3	76.3	70.9
46	36.6	34.3	32.5	29.3	96	83.8	80.3	77.2	71.8
47	37.5	35.2	33.3	30.1	97	84.8	81.2	78.2	72.6
48	38.4	36.1	34.2	30.9	98	85.7	82.2	79.1	73.6
49	39.4	37.0	35.1	31.7	99	86.7	83.2	80.0	74.4
50	40.3	37.9	35.9	32.5	100	87.6	84.0	80.9	75.3

The Complete Smith Chart

Black Magic Design